

Improving Bone-Health Monitoring in Astronauts: Recommended Use of Quantitative Computed Tomography [QCT] for Clinical and Operational Decisions by NASA. J.D. Sibonga and P. Truszkowski on behalf of the NASA Bone Summit Panel for Early Onset Osteoporosis, June 7-8, 2010, Houston, Texas.

DXA measurement of areal bone mineral density [aBMD,g/cm²] is required by NASA for assessing skeletal integrity in astronauts. Due to the abundance of population-based data that correlate hip and spine BMDs to fragility fractures, BMD is widely applied as a predictor of fractures in the general aging population. In contrast, QCT is primarily a research technology that measures three-dimensional, volumetric BMD (vBMD,mg/cm³) of bone and is therefore capable of differentiating between cortical and trabecular components. Additionally, when combined with Finite Element Modeling [FEM], a computational tool, QCT data can be used to estimate the whole bone strength of the hip [FE strength] for a specific load vector. A recent report demonstrated that aBMD failed to correlate with incurred changes in FE strength (for fall and stance loading) by astronauts over typical 180-day ISS (International Space Station) missions. While there are no current guidelines for using QCT data in clinical practice, QCT increases the understanding of how bone structure and mineral content are affected by spaceflight and recovery on Earth. In order to understand/promote/consider the use of QCT, NASA convened a panel of clinicians specializing in osteoporosis. After reviewing the available, albeit limited, medical and research information from long-duration astronauts (e.g., data from DXA, QCT, FEM, biochemistry analyses, medical records and in-flight exercise performance) the panelists were charged with recommending how current and future research data and analyses could inform clinical and operational decisions. The Panel recommended that clinical bone tests on astronauts should include QCT (hip and lumbar spine) for occupational risk surveillance and for the estimation of whole hip bone strength as derived by FEM. FE strength will provide an improved index that NASA could use to select astronauts of optimal bone health for extended duration missions, for repeat missions or for specific mission operations.